Egypt. J. Zool., 32: 255-266 (June,1999) 7th Conference, February 1999

ACTIVITY DENSITY OF SOIL FAUNA IN CULTIVATED LANDS OF MIDDLE EGYPT

II. - SOIL MESOFAUNA ASSOCIATED WITH A CITRUS ORCHARD

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ABSTRACT

This study investigates the activity density of soil fauna in a citrus orchard at Beni-Suef Governorate, Middle Egypt. Samples were collected during the period between February and November 1995 by means of the pitfall trap method. Data were analyzed by the advanced multivariate statistical methods, correspondence analysis and ascending hierarchic classification. The results obtained showed that the most dominant species in the study area and period were *Pheidole* sp., *Monomorium* sp. and *Cataglyphes* sp. (Hymenoptera), Collembola and Tephretidae (Diptera). The distribution of the collected taxa was studied in relation to environmental factors, such as plant cover and agricultural practice.

INTRODUCTION

Activity density of soil fauna in cultivated lands was studied in a potato field (Mikhail and Hussein, 1997), in the fields of tuber field crops (Hussein and Mikhail, 1998) and associated with mixed fruit trees (Gadallah and Mikhail, 1999). The latter study was the first one in this series and investigated the activity density of soil mesofauna in an orchard of mixed fruit trees at Beni-Suef Governorate.

The present work is the second of this series and aims to investigate the community structure of soil mesofauna as well as the three main trophic groups in citrus fruit trees in Bayad El-Arab, Beni-Suef Governorate, Middle Egypt in relation to fruit tree type and the pattern of cultivation practiced in the area.

MATERIAL AND METHODS

The study area and crops

The study comprises the investigation of the activity density of the total soil mesofauna as well as the main functional (trophic) groups: herbivores, detritivores and carnivores, associated with a citrus orchard cultivations at the area of Bayad El-Arab, Beni-Suef Governorate. The orchard trees are: sour orange (*Citrus aurantium*), mandarin (*Citrus reticulata*), lemon (*Citrus aurantifolia*) and fig (*Ficus carica*). However, the latter fruit is not a citrus tree but was included in this study since it grows nearly at the center of the orchard. Its position may affect the community structure of soil mesofauna in this area, This investigation was carried out during the period from February to November 1995.

Method of sampling soil mesofauna

The soil mesofauna were collected from the study area by the pitfall trap method described by Southwood (1978) and Slingsby and Cook (1986). In this method, the number of individuals trapped is primarily dependent on their locomotory activity (Greenslade and Greenslade, 1983; Kromp, 1990; Mikhail 1993). These are called activity densities rather than population densities (Kromp, 1990; Mikhail, 1993; Mikhail *et al.* 1995; Mikhail and Hussein, 1997; Hussein and Mikhail, 1998).

Twenty pitfall traps were used monthly during the study period.

Statistical analysis:

Data of the activity density of the soil fauna were treated by multivariate statistical methods: correspondence analysis CA (Greenacre, 1984) and ascending hierarchic classification AHC (Roux, 1985). The computer calculations for CA and AHC were carried out in Cairo University using DATAVISION programme 1.2 (Roux, 1987) developed for APPLE IIe in BASIC.

RESULTS

A total of 68 species and/or higher taxa of soil fauna were collected in the area of the present study (Table 1). The citrus trees lemon and mandarin attract the majority of the soil fauna taxa, 52 each. On the other hand, the fig and sour orange trees attract lower numbers of soil fauna taxa: 26 and 25, respectively.

Figure 1 shows the results of the application of CA and AHC methods to the data of the activity density of species and/or higher taxa of soil fauna (Table 1). Fourty-seven percent of the total variance is associated with the first (vertical) axis and 39% with the second (horizontal) one. The four fruit trees, sour orange, mandarin, lemon and fig, are separated from each other along the first axis except mandarin and lemon which show great affinity between them. This arrangement is

according to the activity density of soil fauna of each of these shrubs. The sour orange was characterized more or less by 13 species and/or higher taxa. These taxa were Staphilinidae (Coleoptera), Isopoda, Ahididae and Cercopidae (Homoptera), 9 Diptera taxa: Anthomyiidae, Asilidae, Otitidae, Dolichpodidae, Muscidae, Sarcophagidae, *Musca domestica* (Muscidae), *Culex pipiens* (Culicidae) and *Sciaria* sp. (Sciaridae). The fig shrub was characterized by about 11 soil fauna taxa: Acarina, Collembola, unknown taxon of Coleoptera, *Notoxus* sp. (Coleoptera, Anthicidae), Scarabaeidae (Coleoptera), Labiduridae (Dermaptera), Pipunculidae (Diptera), Cicadellidae (Homoptera), Bethyloidea (Hymenoptera), *Cataglyphes* sp. (Hymenoptera, Formicidae) and Chrysopidae larvae (Neuroptera). The mandarin and lemon trees were similar to each other in the faunal composition. They were characterized more or less by 41 species and/or higher taxa of soil fauna. These taxa were Araneida, *Anthicus* sp. (Coleoptera, Anthicidae), *Bruchus* sp. (Coleoptera, Bruchidae), *Sitophilus* sp. (Coleoptera, Curculionidae), Elateridae and Meloidae (Coleoptera), *Pentodon* sp. (Coleoptera, Scarabaeidae), *Zophosis* sp. and other tenebrionids beetle (Coleoptera), Mantidae (Dictyoptera), Calliphoridae, Chironomidae, Chloropidae, Fannidae, Lauxaniidae, Phoridae, Psychodidae, Sepsidae, Sphaeroceridae, Tachinidae and Tephretidae (Diptera), *Stomoxys* sp. (Diptera, Muscidae), *Parasarcophaga* sp. (Diptera, Sarcophagidae), *Syrphus corollae* (Diptera, Syrphidae), *Oligotoma* sp. (Embioptera, Oligotomatidae), Heteroptera, Reduviidae (Heteroptera), Braconidae, Cephidae, Chalcididae and Sphecidae (Hymenoptera), *Camponotus* sp., *Cardiocondyla* sp., *Pheidole* sp. And *Solenopsis* sp. (Hymenoptera, Formicidae), Lepidoptera, Myrmeleontidae (Neuroptera), Acrididae (Orthoptera), Trichoptera and Thysanoptera. A set of 3 taxa were grouped together at the middle of the ordination graph and seemed to be related to all fruit trees. These three taxa were Diptera, *Monomorium* sp. (Hymenoptera, Formicidae) and Orthoptera.

Figure 2 shows the results of the breakdown of soil fauna taxa of the present study into the three main trophic (functional) groups: herbivores, detritivores and carnivores. Generally, the three trophic groups were well represented in all fruit trees. Herbivores were the most dominant group among the three groups followed by detritivores and carnivores. Herbivores were more abundant in the case of mandarin and fig while detritivores were more abundant in the case of fig and the same in the other three fruit trees. Carnivores had the same number in all fruit trees.

DISCUSSION

The agronomic significance of soil fauna (other than pest species) depends upon the intensity of cropping systems because grazing, fire, tillage, inorganic

fertilizers and pesticides generally reduce the species complement and population densities of soil fauna, and override their contribution to soil processes (Anderson, 1988). Agro-ecosystems differ in age, diversity, structure and management, and there exists a great variability in basic ecological and agronomic patterns among different agro-ecosystems (Alteiri, 1991). On the other hand, the composition and diversity of soil animals may differ in agro-ecosystems according to cropping patterns and type (Perfecto and Sediles, 1992) and intensity of agricultural practices (Swift *et al.,* 1996). The area of the present study was not subjected to any of the above mentioned agricultural practices except the difference in fruit trees cultivated. This will lead to the variation in species composition of the individual fruit trees.

In the present investigation, the number of species and/or higher taxa were greatly affected by the pattern of cultivation practiced in the area as compared to the results obtained by Gadallah and Mikhail (1999) who found that the number of soil fauna taxa sampled and the total number of individuals collected from the same area were higher than those obtained in the present investigation. This may be ascribed to the fact that the diversity of the mixed fruit trees (8 different trees) was higher (Gadallah and Mikhail 1999) than that of the 4 citrus fruit trees of the present investigation.

The importance of studying the trophic (functional) groups of the soil fauna populations in order to evaluate the structural composition of these groups in different ecosystems was illustrated by different investigators (Ghabbour, 1991; Mikhail and Hussein, 1997; Hussein and Mikhail, 1998; Gadallah and Mikhail, 1999). In the present study, the trophic groups: herbivores (potential agricultural pests), carnivores (natural enemies of herbivores), and detritivores (essential for soil fertility), were well represented under all fruit trees. These results suggest that all fruit trees have a complex food chain. Results of the three main trophic groups are similar to the results obtained by Gadallah and Mikhail (1999). In the present study, the different fruit trees were cultivated in one field and formed permanent mosaic pattern of cultivation less complicated than the mosaic pattern of cultivation obtained by Gadallah and Mikhail (1999). This lead to slight increase in the abundance of herbivores, excluding ant species, and an increase in ant foraging activity than those associated with mixed fruit trees (Gadallah and Mikhail, 1999).

Host architecture and leaf morphology were among the possible causes which affected the patterns of herbivore densities and abundance (Aguilar and Boecklen, 1992). The results of the present investigation are comparable to those obtained by Gadallah and Mikhail (1999).

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Table (1): Activity density of species and/or higher taxa of soil fauna collected from under different fruit trees (A, mandarin; B, lemon; C, sour orange; D, fig), with trophic (Troph) groups; Herb, herbivores; Det, detritivores; Carn, carnivores.

Taxa	Troph	A	B	C	D
Acarina	Carn	28	45		200
Araneida	Carn	518	324	300	500
Collembola	Det	1190	1287	400	5000
Coleoptera					
Anthicidae					
Anthicus sp.	Herb	42	54		
Notoxus sp.	Herb	168	324	700	1600
Bruchidae					
Bruchus sp.	Herb	14			
Curculionida					
Sitophilus sp.	Herb	14	9		
Elateridae	Herb		9		
Meloidae	Herb	14			
Scarabaeidae					
Pentodon sp.	Det	14			
Other Scarabaeidae		14	54		100
Staphilinidae	Det	14		100	
Tenebrionidae					
Zophosis sp.	Det	616	594	200	600
Other Tenebrionidae		308	423		100
Other Coleoptera		14	18		500
Dermaptera					
Labiduriidae	Det				100
Dictyoptera					
Mantidae	Carn	14			
Diptera					
Anthomyiidae	Det		9	100	
Asilidae	Det			100	
Calliphoridae	Det	14			
Cecidomyiidae	Det		9		

Table (1) Continued.

Taxa		A	B	C	D
Chironomidae	Det	42	27		
Chloropidae	Det		9		
Culicidae					
Culex pipiens	Carn		72	300	
Dolichopodidae	Carn	182	72	300	100
Fanniidae	Det	28	27		
Lauxaniidae	Det		18		
Muscidae					
Musca domestica	Det	42	9	100	
Stomoxys sp.	Det		9		
Other Muscidae	Det	42	27	200	100
Otitidae	Herb		9	100	
Pipunculidae	Carn	14	27		100
Phoridae	Det	70	54		
Psychodidae	Det		9		
Sarcophagidae					
Parasarcophaga sp.	Det		9		
Other Sarcophagidae	Det	42		100	
Sciaridae					
Sciaria sp.	Det	14	45	200	100
Sepsidae	Det	28	45		
Sphaeroceridae		42	45		
Syrphidae					
Syrphus corollae	Herb	28	27		
Tachinidae	Carn	42	36		
Tephretidae	Herb	3122	1701	200	200
Other Diptera		182	135	300	300
Embioptera					
Oligotomatidae					
Oligotoma sp.	Herb	14			

Table (1) Continued

Taxa		A	B	C	D
Heteroptera					
Reduviidae	Carn	14			
Other Heteroptera		42	9		
Homoptera					
Aphidiidae	Herb	392	189	1100	100
Cercopidae	Herb	364	54	400	100
Cicadellidae	Herb	266	297	100	1200
Hymenoptera					
Braconidae	Carn	98			
Bethyloidea	Carn	14	27		100
Cephidae		14			
Chalcididae	Carn	84	99		
Formicidae					
Camponotus sp.	Det	322	648	100	300
Cardiocondyla sp.	Herb	28	702		
Cataglyphes sp.	Herb	1078	378	200	2400
Monomorium sp.	Herb	2408	1314	2200	2200
Pheidole sp.	Herb	16366	7560	6700	9400
Solenopsis sp.	Herb		72		
Sphecidae	Carn		27		
Lepidoptera			9		
Neuroptera					
Myrmeleontidae larvae	Carn	84	54		
Chrysopidae larvae	Carn				100
Orthoptera					
Acrididae	Herb	14			
Other Orthoptera		56	135	300	300
Trichoptera	Det	70	99		
Thysanoptera		14			
Isopoda	Det	280	315	1400	200

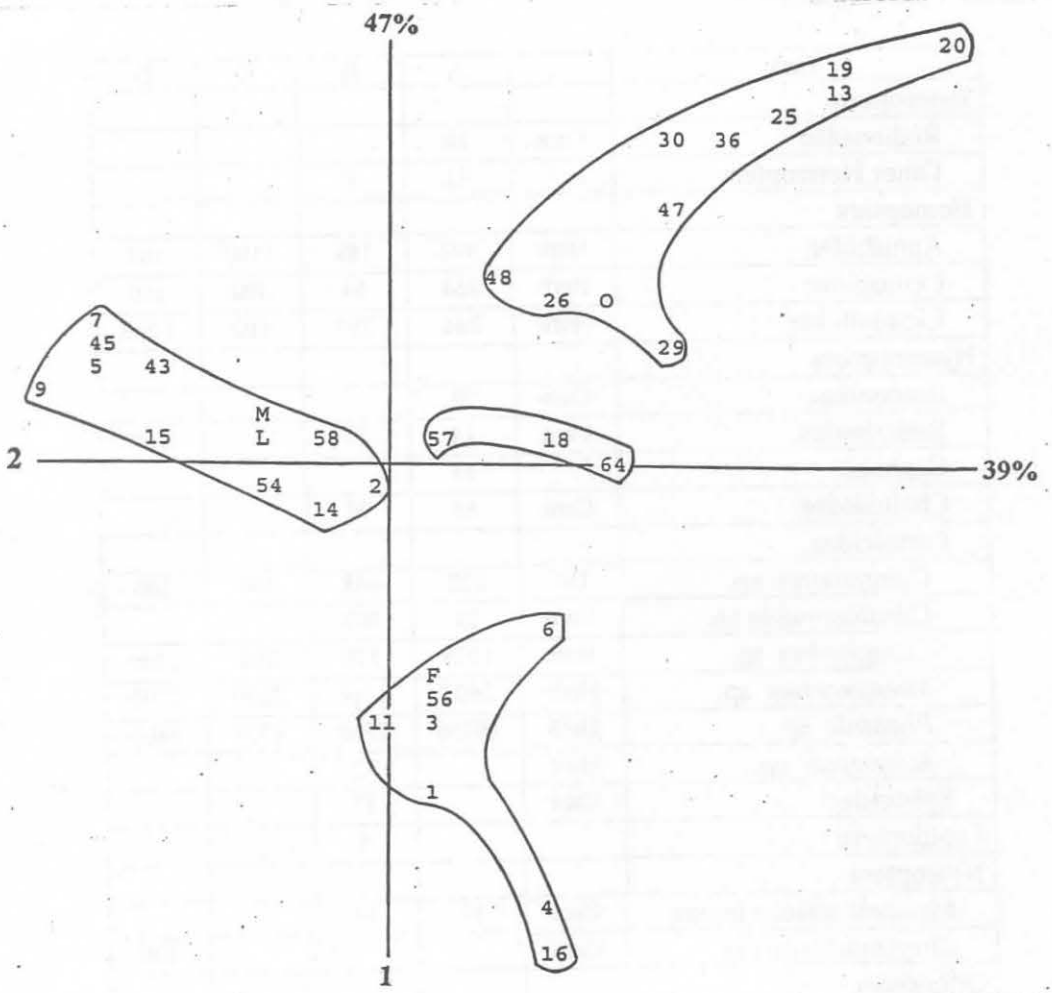

Fig. (1): Graphical representation of the application of CA and AHC methods to data of the activity density of soil fauna species and/or higher taxa . Letters: M, mandarin; L, lemon; F, fig; O, sour orange. Numbers 1-68 are species and/or higher taxa: 1, Acarina; 2, Araneida; 3, Collembola; 4, Coleoptera; 5, *Anthicus* sp.; 6, *Notoxus* sp.; 7, *Bruchus* sp.; 8, *Sitophilus* sp.; 9, Elateridae; 10, Meloidae; 11, Scarabaeidae; 12, *Pentodon* sp.; 13, Staphilinidae; 14, *Zophosis* sp.; 15, Tenebrionidae; 16, Labiduriidae; 17, Mantidae; 18, Diptera; 19, Anthomyiidae; 20, Asilidae; 21, Calliphoridae; 22, Cecidomyiidae; 23, Chironomidae; 24, Chloropidae; 25, *Culex pipiens;* 26, Dolichopodidae; 27, Fanniidae; 28, Lauxaniidae; 29, Muscidae; 30, *Musca domestica;* 31, *Stomoxys* sp.; 32, Otitidae; 33, Pipunculidae; 34, Phoridae; 35, Psychodidae; 36, Sarcophagidae; 37, *Parasarcophaga* sp.; 38, *Sciaria* sp.; 39, Sepsidae; 40, Sphaeroceridae; 41, *Syrphus corollae;* 42, Tachinidae; 43, Tephretidae; 44, *Oligotoma* sp.; 45, Heteroptera; 46, Reduviidae; 47, Aphidiidae; 48, Cercopidae; 49, Cicadellidae; 50, Braconidae; 51, Bethyloidea; 52, Cephidae; 53, Chalcididae; 54, *Camponotus* sp.; 55, *Cardiocondyla* sp.; 56, *Cataglyphes* sp.; 57, *Monomorium* sp.; 58, *Pheidole* sp.; 59, *Solenopsis* sp.; 60, Sphecidae; 61, Lepidoptera; 62, Myrmeleontidae larvae; 63, Chrysopidae larvae; 64, Orthoptera; 65, Acrididae; 66, Trichoptera; 67, Thysanoptera; 68, Isopoda.
Point 32 with 19; 38 with 29; 68 with 47; 49 with 3; 63 with 16; 33, 51 with 1; 10, 12, 17, 21, 44, 46, 50, 52, 65 and 67 are with 7; 8, 23, 27, 34, 39, 40, 41, 42, 53, 62 and 66 are with 5; 22, 24, 28, 31, 35, 37, 55, 59, 60 and 61 are with 9.

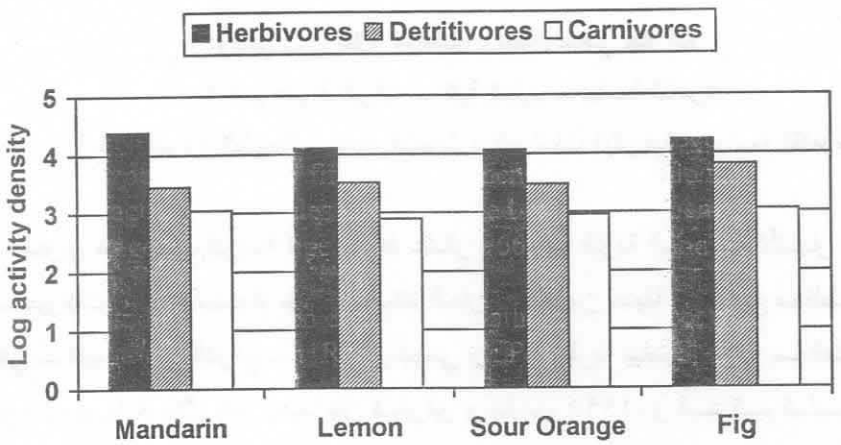

Fig (2) Breakdown of soil fauna into the three main trophic groups under different fruit trees

المجلة المصرية لعلم الحيوان
المجلد ٣٢ (يونية ١٩٩٩)

المؤتمر السابع
(فبراير ١٩٩٩)

كثافة نشاط حيوانات التربة في الأراضي الزراعية
٢ - حيوانات التربة المتوسطة الحجم المصاحبة لأشجار الموالح

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أجري هذا البحث لدراسة كثافة نشاط عشائر حيوانات التربة المصاحبة لأشجار الموالح. جمعت حيوانات التربة باستخدام طريقة مصائد الحفر و ذلك من حديقة موالح مختلطة و هي اليوسفي ــ الليمون ــ النارنج ــ التين البرشومي وذلك في قرية بياض العرب بمحافظة بني سويف شهريا خلال الفترة فيما بين فبراير و مارس ١٩٩٥. و قد تم تحليل نتائج الدراسة بالطرق الإحصائية المتقدمة مثل التحليل التوافقي و التقسيم الهيراركي حيث أظهرت الدراسة أن حيوانات التربة السائدة هي أنواع عديدة من النمل ذات الأحجام الكبيرة و الصغيرة و الكولومبولا و بعض أنواع الذباب. كما أظهرت الدراسة أيضا مدي تأثر كثافة نشاط حيوانات التربة بنمط الزراعة و أساليبها المتبعة و الدائمة.